

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: October 11, 1980

Project Title: Transportation of Radioactive Materials

Project No: E-26-658 (Continuation of B-10-667 which began 1/2/80)

Project Director: Dr. Melvin W. Carter

Sponsor: Southern States Energy Board; Atlanta, GA 30338

Agreement Period: From 7/1/80 Until 2/26/82
~~12/25/81~~

Type Agreement: Subcontract SSEB-GT No. SS-47916-003 RMT (Under DOE Contract No. DE-AC09-80ET47916)

Amount: \$89,478

Reports Required: Topical Reports of Findings and efforts

Sponsor Contact Person (s):

Technical Matters

M. K. Sasser
Project Engineer
Spent Fuel Project Office
Department of Energy
Savannah River Operations Office
P. O. Box A
Aiken, SC 29801
Phone (801) 725-3980

Contractual Matters

(thru OCA)

W. Scott Fellows
Director of Special Programs
One Exchange Place
Suite 1230
Atlanta, GA 30338
Phone (404) 455-8841

Defense Priority Rating: None

Assigned to: Nuclear Engineering (School/Laboratory)

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SPONSORED PROJECT TERMINATION/CLOSEOUT SHEETDate 3/2/84Project No. E-26-658School/~~Lab~~ NE

Includes Subproject No.(s) _____

Project Director(s) Dr. M. W. CarterGTRI / ~~GK~~Sponsor Southern States Energy Board, Atlanta, GATitle Transportation of Radioactive MaterialsEffective Completion Date: 2/26/82 (Performance) 2/26/82 (Reports)

Grant/Contract Closeout Actions Remaining:

☒ None☐ Final Invoice or Final Fiscal Report☐ Closing Documents☐ Final Report of Inventions☐ Govt. Property Inventory & Related Certificate☐ Classified Material Certificate☐ Other _____Continues Project No. B-10-667

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TRANSPORTATION OF RADIOACTIVE MATERIALS

DRAFT

TOPICAL REPORT

VOL. III. Emergency Response to Transportation
Accidents Involving Radioactive Materials

Prepared By
Melvin W. Carter
and
Bernd Kahn

Southern States Energy Board
One Exchange Place, Suite 1230
Atlanta, Georgia 30338

Under DOE Contract DE-AC09-80ET47916

March, 1982

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TECHNICAL STATUS

This draft technical report is being transmitted in advance of DOE review and no further dissemination or publication shall be made of the report without prior approval of the DOE Project/Program Manager.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

NTIS Price Codes

Printed copy: (refer to pricing schedule code, page 3)
Microfiche copy: A01 (all microfiche are priced A01)

ACKNOWLEDGEMENTS

The authors want to thank Pam Henderson, Libby Rhoe, and Lynn Cathey, each a graduate student in the School of Nuclear Engineering and Health Physics, for their contributions. We are also indebted to the participants in the two SSEB Workshops on Transportation of Radioactive Material and especially to Dale McHard, State of Oklahoma, and Leonard Solen, City of New York, for serving as chairmen for Emergency Response sessions in these workshops.

Kent Sasser, DOE Project Officer, was most helpful and supportive as were the several members of the SSEB staff. In this latter group special thanks go to Scott Fellows, SSEB Project Officer, and Jane Clark and Nancy Kaiser for library assistance.

We also express appreciation to Sharon Reeves and Ella Harris for their work with the manuscript.

FOREWORD

During the past several years there has been considerable interest in the transportation of hazardous materials and much of this has focused on radioactive materials. Attention is usually attained by accidents and incidents and to a lesser extent by jurisdictional disagreements debated in the public arena.

It is thus desirable, on a periodic and systematic basis, that the experience data base be examined and evaluated to determine what it contains in the way of useful information. This study was conducted by the Southern States Energy Board for the U.S. Department of Energy/Savannah River Operations, Spent Fuel Project Office, for this purpose.

Efforts were divided into three parts which were coordinated by the principal investigators and staff of the Southern States Energy Board. Major emphasis was placed on those states and areas covered by the SSEB although other jurisdictions are discussed for specific reference purposes.

This report is an account of the activities of Project 3.0, "Emergency Response to Transportation Accidents Involving Radioactive Materials," which is an inherent part of the two-year study titled "Radioactive Material Transportation -- a Regional Program."

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS. . . . .	.iii
FOREWORD. . . . .	.iv
LIST OF TABLES. . . . .	.vi
EXECUTIVE SUMMARY . . . . .	.vii
1.0 INTRODUCTION . . . . .	.1
2.0 TRANSPORTATION OF RADIOACTIVE MATERIALS. . . . .	.4
2.1 Radioactive Materials . . . . .	.4
2.2 Transportation. . . . .	.8
2.3 Regulation. . . . .	.15
2.4 Packaging and Handling. . . . .	.16
3.0 EMERGENCY RESPONSE . . . . .	.20
3.1 Emergencies . . . . .	.20
3.2 Responsibilities. . . . .	.25
3.3 Preparedness. . . . .	.26
3.4 Response. . . . .	.29
4.0 THE SSEB REGION. . . . .	.34
4.1 State Response Plans. . . . .	.34
4.2 Carrier Respcnse Plans. . . . .	.40
4.3 Response Capabilities . . . . .	.41
5.0 CONCLUSIONS AND RECOMMENDATIONS. . . . .	.43
6.0 REFERENCES . . . . .	.46
7.0 APPENDIX . . . . .	.53

LIST OF TABLES

Table		Page
1	Radioactive Material Packaging. . . . .	.17
2	Radioactive Material Labelling. . . . .	.19
3	Hazardous Material Incident Reports in 1971-1980. .	.21
4	Radioactive Material Transportation Accidents Involving Type B Packages . . . . .	.22
5	Potential Hazards Guide 63. . . . .	.30
6	General Guidance for Immediate Actions in the Event of a Radiation Incident by the First Individuals on the Scene. . . . .	.32
7	Transportation Radiation Emergency Response Plan (TRERP) in SSEB Region . . . . .	.35

EXECUTIVE SUMMARY

This report summarizes the efforts conducted for Project 3 which concerned itself with Emergency Response to Transportation Accidents Involving Radioactive Materials. It is an inherent part of the broader two-year study, Transportation of Radioactive Materials, carried out by the Southern States Energy Board.

The objectives of the Project are:

1. Evaluate the scope and adequacy of the emergency response plans of states in the SSEB region as they pertain to accidents involving all classes of hazardous materials and particularly radioactive materials.
2. Evaluate consistency of emergency response plans and provisions for cooperation should an incident involve more than one state.
3. Recommend appropriate changes in the plans that can enhance their effectiveness in dealing with accidents.
4. Evaluate state-federal relationships with respect to emergency response planning for radioactive materials transportation accidents in southern states and recommend areas for enhancement and cooperation in the development of new or improved plans.

Available information was identified, reviewed and evaluated. This specifically included the collection of current emergency response plans from pertinent states, federal agencies, shippers, and carriers of radioactive materials. Personal contacts were made to clarify and/or supplement the information as warranted.

Two workshops were held November 1980 and November 1981 as integral parts of this two-year effort. These workshops provided the opportunity to discuss specific areas of interest and to exchange information among those having varied backgrounds and responsibilities. Input from these sessions was incorporated into the respective studies.

The record indicates the transport of large numbers and quantities of radioactive materials on an annual basis in the U.S. with very infrequent accidents and incidents. Most of these do not result in release of radioactive materials or increased radiation exposures and thus do not pose a direct threat to public health and safety.

Control is achieved largely by enforcement of regulatory requirements for appropriate packaging, labelling, handling,

and transporting of radioactive materials. These requirements are primarily those of the U.S. Department of Transportation with important contributions by several other federal agencies.

When transport accidents and incidents occur, the potential for hazard is reduced even more by having emergency response capability available for rapid deployment according to plans designed for the purpose. The sixteen states in the Southern States Energy Board region have such plans and a reasonably good record of implementation when called upon to perform emergency response services.

Planning and preparations for emergency response have been given considerable attention recently and this is reflected in the current status of state and other relevant emergency response plans as well as the degree of confidence in the ability to effectively respond in the event the emergency response service is needed.

The Southern Mutual Radiation Assistance Plan serves as a model for inter-state and inter-agency cooperation during emergencies involving radiation and radioactivity within the region served by the Southern States Energy Board. A similar but broader plan could serve the same purposes on a less provincial basis.

Recommendations are made which would strengthen the state emergency response programs and increase their capabilities to promptly respond to transport accidents and incidents involving radioactive materials and to effectively control and mitigate adverse effects on public health and safety. Such efforts require contributions from state, federal, and local governmental agencies as well as from shippers and carriers. There are also very positive roles which should be played by groups such as the Southern States Energy Board in these efforts.

EMERGENCY RESPONSE TO TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

1.0 INTRODUCTION

Radiation and radioactive materials are used extensively throughout the United States in virtually every aspect of our society--industrial, agricultural, medical, cultural, military, energy production, and research. Their use normally involves production or manufacture, distribution, application and disposal of unused products.

Transportation connects this chain of production and application and may well involve a particular product a number of times. In the nuclear fuel cycle, raw materials are mined, transported to processing facilities in which various steps are performed sequentially at different sites, used in other locations; finally, the waste is sequestered at a waste management site. Highway, air, water, and rail modes of transportation are used to connect this network or matrix in an effective manner.

Another example is rapid transport, usually by air and highway, of radionuclides used in medical procedures from production plants to hospitals and clinics for application. For safety reasons, these are normally relatively short-lived materials that must be made promptly available for application at the place of use.

There are also applications in which transportation is an inherent and indispensable part or provides the central theme. The former is exemplified by use of radiographic sources which are used in the field. Such sources are transported from job to job as the need arises. An example of the latter is nuclear power used to provide the energy for motion, as in a nuclear powered submarine.

Thousands of individual transportation steps are at present used to transport annually of the order of a million packages of radioactive material in the United States. It is expected that expanded uses for radioactive materials and radiation sources will call for additional transportation to provide this vital step. This is especially true with regard to the nuclear fuel cycle: increased numbers of widely separated commercial nuclear power plants and supporting facilities will require appropriate management of the radioactive wastes generated at various places throughout the cycle.

In order for these systems to be operated effectively, it is necessary to assure health and safety and minimize environmental effects. This applies at the place of use and at each stage of the transportation cycle. Effective and positive control must be maintained. Should this be interdicted, it is obligatory that emergency response capability be readily available for quickly rectifying the situation.

A good general characterization of the ability to respond effectively to an emergency situation is literally applying to all conceivable circumstances the motto of the Boy Scouts: "Be prepared." This environment of preparedness requires foresight, dedication, resources, planning, and commitment. The results are tangible, real, and rewarding. Pasteur said, "chance favors the prepared."

Effective emergency response consists of actions which prevent or minimize adverse effects and ramifications of an accident on a prompt basis, correct or control the situation which produced the emergency, protect persons and property, and mitigate detrimental sequences which may have been initiated prior to application of the response actions.

This study examines the transportation of radioactive materials, reviews the experience and potential for transportation accidents, evaluates the plans established to provide emergency response services, and makes recommendations to improve these. Emphasis is placed on planning responses to accidents involving transportation of radioactive materials and on developing the capability to respond effectively to emergencies.

This Project--the third in a 3-part effort by the Southern States Energy Board (SSEB) -- has the following objectives:

1. Evaluate the scope and adequacy of the emergency response plans of states in the SSEB region as they pertain to accidents involving all classes of hazardous materials and particularly radioactive materials.
2. Evaluate consistency of emergency response plans and provisions for cooperation should an incident involve more than one state.
3. Recommend appropriate changes in the plans that can enhance their effectiveness in dealing with accidents.
4. Evaluate state-federal relationships with respect to emergency response planning for radioactive materials transportation accidents in southern states and recommend areas for enhancement and cooperation in the development of new or improved plans.

Particular tasks to be undertaken by Project 3 include (SS80a):

1. Collect and review the SSEB states' emergency response plans for hazardous materials transportation accidents to determine adequacy and status of plan development.

2. Collect and review, on a selective basis, such documents as company manuals, driver training programs and qualifications standards, etc. from traditional transporters of radioactive materials to determine general industry capabilities in dealing with radioactive materials transportation accidents.

3. Analyze SSEB states' emergency response plans pertaining to radioactive materials transportation accidents for consistency with federal regulations and similar plans of adjoining states. Determine the compatibility of the plans with established procedures within the transportation industry.

4. Recommend relevant actions to be taken for improvement of the emergency response plans.

5. Confer with appropriate state and federal officials regarding implementation strategies for integrating state/interstate/federal plans and procedures for dealing with radioactive materials transportation accidents.

6. Conduct workshops to report to state and federal officials the findings of the study. Solicit the comments of workshop participants regarding integrated state/interstate/federal implementation strategies.

7. Prepare a topical report on efforts, findings, and recommendations.

Of the two other parts of the SSEB program, project one reviews and analyzes state and regional radioactive materials transportation plans in order to identify and resolve socioeconomic and institutional barriers. Its report, entitled "Identification of Socioeconomic and Institutional Barriers to Radioactive Materials Transportation," (SS81a) is available. Project 2 has the assignment to evaluate and develop regional methodologies for reporting and monitoring the transport of radioactive materials. The findings and recommendations of this effort are in a report by Nilsson and Hill (Ni82).

The SSEB (formerly known as the Southern Interstate Nuclear Board) was established in 1961 under the authority of Public Law 87-563, the Southern Interstate Nuclear Compact.

Its members are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

This Board has long had an interest and programs concerned with nuclear energy, including transportation of radioactive materials and emergency planning. Published reports of the SSEB in these areas of interest include "Radioactive Materials Transportation" (SI73) and "The Southern Mutual Radiation Assistance Plan" (SE81). Additional information concerning the SSEB is in its most recent annual report (SS81b).

The three related studies are concerned with the geographical area served by the SSEB. In some cases, however, the frame of reference is much broader and may extend to other states as well as to foreign countries. Such concerns include experience in transporting used nuclear fuel elements and the rules and regulations for transport of radioactive materials, which in most countries are based on guidance by the International Atomic Energy Agency.

2.0 TRANSPORTATION OF RADIOACTIVE MATERIALS

2.1 Radioactive Materials

Radioactive materials (RAM) are those substances which contain energetically unstable atoms. In the process of becoming stable, they emit radiation and thus demonstrate radioactivity. Alpha and beta particles and neutrons may be emitted as well as photons (gamma rays and x-rays).

Many of the materials transported are of value due to their radioactive nature. Examples are the gamma rays from ^{137}Cs , the neutrons from an americium-beryllium source, and the beta particles from ^3H .

Others are used as generators of a useful product; for example ^{99}Mo produces $^{99\text{m}}\text{Tc}$. This latter radionuclide is used for human organ imaging techniques. Several million such examinations are performed annually in the United States.

Another type of radioactive material which is transported extensively is fissile material. This designation includes ^{235}U , ^{239}Pu , and ^{233}U used as fuels in nuclear reactors. Their characteristic use is in generating large amounts of

energy when fissioned by neutrons under appropriate circumstances. In parallel, source materials such as ^{238}U and ^{232}Th are transported for their ability to be converted to fissile materials by absorption of neutrons and subsequent decay to ^{239}Pu and ^{233}U , respectively.

There has been a reasonably steady increase in the production and use of radioactive materials and in the generation of by-products and waste materials. These activities are expected to continue growing during the foreseeable future.

The major area of uncertainty is in the management of radioactive wastes and related transportation requirements. Commercial low-level wastes are at present being transported to shallow land burial sites in South Carolina, Nevada, and Washington. Criteria as to what wastes are acceptable and the quantities that could be received have been varied at these sites. Greater capacity will be needed in the near future because that of the current waste management facilities is finite and limited.

Uncertainties regarding policies and procedures for the operation of these sites have helped produce the situation in which volumes of low-level waste are being generated and stored at the sites of generation until appropriate arrangements can be made for their transport and disposal.

Another major area of uncertainty involves the lack of a definitive policy in handling used fuel elements from commercial power reactors. For many years, the expectation was that these used fuels would be reprocessed to return the uranium and plutonium into the nuclear fuel cycle for their intrinsic energy value. The high-level waste would be disposed of at a federal high-level radioactive waste repository. This general situation was changed drastically by Presidential declaration early in 1977. The stated policy forbade commercial fuel reprocessing. It appeared that used fuel elements would be treated, at worst, as high-level radioactive waste or, at best, as a resource which someday might have value. They would be stored in some suitable fashion for an indefinite period.

These policies are under review and it is widely expected that they will be changed. They impact a great deal on transportation. At present, used fuel elements are stored primarily at the commercial nuclear power plants that are the sites of generation. These have rapidly diminishing capacity to continue this practice.

Changes in policy to allow and encourage fuel reprocessing and high-level waste management would result in many

transportation steps. Used fuel elements -- the present backlog as well as those produced in the future -- would need to be transported to fuel reprocessing plants. The products from such plants, i.e. high-level radioactive waste, useful quantities of uranium and plutonium, and related wastes would require transport to appropriate locations within the closed nuclear fuel cycle.

Radioactive materials can be categorized in a number of useful ways: by the source or method of production, the agency or group involved with their use, the regulatory framework, and the functional use or application. By application or functional category (Ca82) the individual groups are radio-pharmaceutical; radionuclides for industry, research or education; radiation sources for medicine (teletherapy) or industry (radiography); nuclear fuel cycle materials; and radioactive waste from all these uses. On occasions it will be desirable to impose a fine structure on certain of these categories as in discussing transport of high-level waste, low-level waste, and used fuel elements.

Two other categories of specialized radioactive materials should be mentioned because they are transported, can be involved in accidents for which emergency response is appropriate, and are handled generally in a particular but circumscribed manner by designated groups (agencies). These are nuclear weapons and weapon components and shipments of certain nuclear materials which are owned, handled, and used by federal agencies.

The first nuclear weapon was built, transported, and tested in 1945; such devices have been transported ever since. They are different from usual radioactive materials primarily with respect to criticality, association with high explosives, security, and safeguards. These differences impose the need for special requirements during any accident sequence, including use of trained personnel.

Certain special circumstances also may relate to the transport of selected nuclear materials which are owned, used, and transported by federal agencies. The usual and reasonable requirement is that all procedures be at least as stringent as those imposed by regulatory agencies on other groups who might transport similar materials.

Radioactive materials (radionuclides) have been used extensively in medicine, industry, research, education, the nuclear fuel cycle, and agriculture. These uses were established many years ago and have expanded rapidly as newer applications have been identified and developed. An overview presented here is taken primarily from the "Final Environmental Statement on the Transportation of Radioactive Material by Air

and Other Modes" by the U.S. Nuclear Regulatory Commission (OS77a). This is a comprehensive report which presents a good summary of the transportation of radioactive materials.

Nuclear medicine, which is the clinical application of radioactive materials, has become an important and major branch of medicine during the past several decades. The numbers of medical procedures performed annually as well as the numbers of curies of activity involved have been in the millions and are increasing. These procedures involve thousands of clinics and hospitals throughout the United States. Radionuclides, such as ^{99m}Tc , ^{131}I , ^{198}Au , and ^{203}Hg , are used for imaging and scanning.

In addition to diagnostic procedures, specific radionuclides are used as therapy sources. In general, these teletherapy sources of ^{60}Co and ^{137}Cs are used to destroy localized malignancies. Such sources are usually solid in form, contain several thousand curies of the radiosotope, and last a number of years before requiring replacement by the manufacturer.

Well-logging, radiography, gauging, and food irradiation are examples of industrial and/or research applications of radionuclides. Well-logging normally involves relatively small neutron sources (such as americium-beryllium) and a ^{137}Cs source. These sources are transported and used in the field to identify underground geological properties. Radioisotopes are also used extensively to inject into wells of various sorts to determine flow characteristics.

Radiography normally utilizes ^{192}Ir to examine structural integrity. Such sources are in radiography cameras which can readily be transported and used in the field at multiple locations. They are usually about 100 curies in size when new and replaced when they have decayed to about 30 curies. Their use involves transport not only during their useful lives but also between the manufacturer and user.

A large number of radioisotopes, in amounts ranging from millicuries to several curies, are used as gauges. Applications are for measuring material thickness, level, and density, coating thickness and moisture content. Such sealed sources include ^{226}Ra , ^{137}Cs , ^{60}Co , ^{90}Sr , and ^{241}Am . Sources of ^{60}Co and ^{137}Cs in quantities up to several hundred thousand curies are utilized in food irradiation for preservation and for other purposes.

The nuclear fuel cycle involves all steps between mining uranium ores and ultimate disposal of associated wastes. The center piece of the cycle is the utilization of nuclear fuels in nuclear power plants for producing electricity.

Most nuclear source materials (uranium ores) are mined in certain western states, milled in nearby locations, refined into uranium hexafluoride, enriched in ^{235}U content (about 2-4%), fabricated into fuel rods of UO_2 , used as an energy source in commercial nuclear power plants, and at present stored at the reactor (power plant) in water pools awaiting additional processing. This additional processing could involve disposal as a waste material (used fuel elements) or, most likely, treatment in a fuel reprocessing plant which separates useful plutonium and uranium from the high-level radioactive waste.

The plutonium and uranium would be recycled for use of their fuel values, i.e. the uranium into the enrichment process whereas the plutonium would become a part of mixed oxide fuels for other reactors. The high-level waste would be processed and transported to a federally owned high-level radioactive waste repository.

The nature of the nuclear activities of these materials and the manner in which they are handled and transported are changed drastically during the fission process which occurs in the reactor (nuclear power plant). Prior to that time, the radioactive materials represent a minimal radiological situation and one in which handling procedures and problems are fairly simple and straightforward.

Fission in the nuclear power plant creates millions of curies of radioactivity and products which are extremely radioactive as well as thermally active. Their handling and transport now require massive shielding for protection and cooling systems for heat dissipation.

Used fuel elements and high-level radioactive waste (when it becomes available from reprocessing plants), both contain millions of curies of radioactivity. They must be specially enclosed and packaged in designed, highly shielded casks for transport.

Radioactive waste of various compositions is generated at all stages of the nuclear fuel cycle and at various points in the processing and application of radioactive materials for useful purposes. Such wastes are defined in several manners but may include uranium mill tailings (high volume, low radioactivity content), low-level waste, high-level waste, transuranic waste (TRU), and combinations of certain categories.

2.2 Transportation

Large amounts of radioactive materials are transported in the United States. These quantities are measured in various

ways, i.e. in number of packages, total transportation index (TI), curies, weight, and volume.

There is a large range in the quantities or amounts of radioactivity which are transported as a package or a shipment. These amounts are usually measured in units of radioactivity, i.e. curies (Ci) or becquerels (Bq). Fissile material is also characterized in terms of weight, e.g. grams or tons. Individual packages range from fractions of grams in weight to many tons and from a few Bq to millions of Ci.

Radioactivity is transported in all physical forms--solids, liquids, and gases. The form depends on the nature or use of the material. The majority of the RAM is undoubtedly solid. In certain cases, a very small weight of material in transit potentially can represent a much more hazardous situation than a shipment of other RAM containing many tons.

The effective control of RAM is based in part on proper packaging and handling with due regard to the type of radiation and the amounts (radioactivity content). This results in the use of a wide range of packages or containers which are selected for the job to be done. These range from inexpensive metal cans and cardboard boxes to multi-million dollar casks used to transport used fuel elements from reactors. The latter have elaborate and massive shielding as well as heat removal systems. The cans and cardboard boxes are expendable whereas the casks are used for many years.

These drastic differences in the treatment and control of various radioactive materials, as appropriate in each individual case, during their transport can result in a lack of understanding by the public that may conflict with emergency response by individuals in such efforts. They may also help contribute to a public perception that transport of radioactive materials is more hazardous than is demonstrated by a careful evaluation of the extensive experience which is available for review.

Drum and Reinhold have compiled a 36-page selected bibliography of the literature available on the transportation of nuclear materials during the period January 1970 through December 1979 (Dr80). This compilation presents a broad overview of the literature, although emphasis is placed on references to materials on spent fuel and waste. Another extensive bibliography is contained in the report "Transportation of Radionuclides in Urban Environs: Draft Environmental Assessment" by Finley, et al. (Fi80). This bibliography is some 86 pages in length and contains well over 1,200 references.

A number of radioactive materials are shipped or transported many times during their useful existence and in some

cases the physical form and overall characteristics are changed in the sequence of use. An example of this type of sequence is uranium which is mined in Africa, shipped to the U.S. in the form of U_3O_8 (yellowcake), scheduled for enrichment in Oak Ridge, Tennessee, then for shipment to France for fabrication into fuel elements which would be transported back to Africa for use in South Africa's first nuclear power station which is under construction near Cape Town. This is the current plan and will occur if several difficulties can be overcome.

The largest quantities of radioactive materials are shipped as used fuel elements, wastes, and sealed sources for use in industrial and research applications. Used fuel elements currently are not shipped often but rather are stored at the commercial nuclear power plant of origin. This situation will change with the availability of reprocessing plants and/or one or more federal high-level waste repositories. Estimates regarding the generation of fuel elements, their processing, and the handling and disposal of the resulting high-level radioactive waste and other waste categories have been presented for a number of possible growth scenarios during the period from 1975 to 2000 (ON76).

An available report (ON76) has a comprehensive analysis of the possible use of mixed oxide fuel in light water reactors on a widescale basis. It also presents possible conditions of use.

Records of the amounts (curies) and volumes of low-level radioactive waste sent to and processed by the three commercial low-level burial sites have been summarized by Guilbeault (Gu80) for the year 1979. About 477,000 curies of radioactivity contained in a volume of about 80,000 cubic meters were buried in 1979. The distribution of quantity and volume for the burial sites located at Barnwell, SC, Beatty, NV, and Richland, WA is 314,942 Ci ($63,443m^3$), 8,932 Ci ($6,491m^3$), and 153,563 Ci ($9,980m^3$), respectively. Relative curie amounts of these wastes by source are commercial nuclear power plants (19.6%), institutional and industrial (69.0%), and governmental/military (11.4%). These numbers are calculated from data from Guilbeault (Gu80). It is noted that the largest fraction is calculated by difference.

This reference (Gu80) also points out that, for the eighteen-year period beginning in 1962, the annual volume of low-level waste disposed of at commercial burial sites has increased steadily. Each state has some low-level waste generated within its boundaries and these waste volumes are identified and characterized on a state-by-state basis. Typical radionuclides are associated with the low-level waste from commercial nuclear power plants are identified as ^{51}Cr ,

^{54}Mn , ^{59}Fe , ^{58}Co , ^{60}Co , ^{65}Zn , ^{134}Cs , ^{136}Cs , ^{137}Cs , ^{140}Ba , and ^{141}Ce .

Other projections of radioactive waste materials generation and their impact on the transportation system were addressed in a study conducted by Battelle for the Transportation Technology Center of Sandia Laboratories (Bat80). These projections of waste volumes, amounts, and other characteristics for the period 1980-2000. They are presented for such categories as fuel fabrication, yellowcake conversion, spent fuel, low-level wastes from light water reactors, institutional wastes, and defense waste. In all cases, increases are projected in wastes as measured by quantity, volume, weight, numbers of shipments, and numbers of transport trips.

Several projections for generation of non-transuranic wastes from 1975 to 2000 are compared in the report "Environmental Assessment for Barnwell Low-Level Radioactive Waste Disposal Facility" (CN80a). The projections, by the Environmental Protection Agency, the Energy Research and Development Administration, the Nuclear Regulatory Commission in GESMO, and Chem-Nuclear Systems Staff, all show 2 to 3 orders of magnitude in increased waste volume, with large variability among estimates. The degree of variability increases with projection time.

Sealed sources vary considerably in size depending upon application in medicine, radiography, research, or industrial uses and as food sterilization. Such sources typically employ ^{60}Co , ^{137}Cs , or ^{192}Ir , which emit relatively high-energy gamma rays.

Battelle-Pacific Northwest Laboratories (OS76a) conducted an extensive survey of radioactive materials shipments in the U.S. in 1975. Results from this survey are still in use. For example, the current literature refers to the presented estimate of number of radioactive materials transported annually in the U.S. of 2.5-million packages.

In 1975, approximately 500-billion packages of all commodities were transported annually in the U.S. (OS77a). Some 100-million of these involve materials which are classified as hazardous such as flammables, explosives, poisons, corrosives, and radioactive materials. According to Grella (Gr76), the RAM category of 2.5-million packages includes shipments made by an estimated 16,000 shippers.

Recent results (Ca82) would indicate that perhaps the numbers of shipments may not have increased as dramatically as earlier predictions would have forecast. This finding could be tempered by the small population studied, or the exclusion of "limited quantity" packages; on the other hand, it could

reflect changes in the industry. There has certainly been a trend to use packages containing multiple sources of RAM and to consolidate packages for shipment. Such changes have been imposed primarily for economic reasons although they do represent technical modifications in the nature of the shipping industry.

It should be obvious that the numbers of shipments are considerably less than the number of packages of RAM which are transported. This ratio is highly variable and depends upon a number of factors. However, both parameters impact planning for emergency response and should be borne in mind.

In recent considerations by the U.S. Nuclear Regulatory Commission for evaluating the conditions under which governors will be notified in advance of shipments of certain radioactive materials through their state, it was estimated that approximately 389,000 shipments of nuclear waste will occur in 1985 and that about 24,000 of these will be in Type B packages (NR80). These containers are designed to withstand normal transport as well as specified types of accidents. In addition, advance notice would also be considered for several hundred shipments of used nuclear fuel in 1985.

Radioactive materials are transported by a variety of transportation vehicles using the network or medium particular to those types of vehicles. Extremes range from exempt quantities of RAM sent through the mail to a shipment by rail or highway of a cask, weighing many tons, that contains hundreds of thousands of curies as an inherent part of used fuel elements.

Most radioactive materials are transported by highway, rail, and air systems. In a number of cases, several modes of transport are involved in a given trip between points of origin and destination.

Major factors in the determination of the type of transportation system to use for a given package (shipment) of radioactive material are type and amount of radioactivity, shielding requirements (weight), physical half-life of material (importance of time), needs for cooling, safeguards considerations, convenience, and cost. A brief discussion of these factors is given to assist in the understanding of the process by which the transportation mode is selected.

The type of radioactivity refers to the kind of radiation emitted by the material being transported. The amounts of radioactivity (curies) and weight, or volumes of material will also help determine the selection of the transport mode. These are important considerations in determining the shielding required, including the nature and weight of the shielding

material. Usually, the weight of the radioactive material is insignificant in comparison to the weight of its required shielding.

Physical half-life determines the time period in which the radioactive material is useful. This factor, of course, is directly related to the amount (curies) of material. It also helps determine the need for speed in getting the substance to the place of application or use; e.g. short half-lived radioisotopes used in medical and research applications are more apt to be transported by air.

Casks with cooling systems are required when heat generated through radioactive decay requires continuous dissipation. This usually occurs in transporting used fuel elements and could be needed for certain high-level waste shipments.

Safeguards considerations are a feature of the specific nature of the material and its potential uses and relates to physical protection (possession). It is one important aspect regarding selection of the transportation system.

Routing has long been a point of contention between shippers, carriers, and federal agencies on one hand and various state and local governments on the other. Some groups consider the present system to be effective and safe and that additional routing requirements are unnecessary. The counter argument has been that states and local agencies are more knowledgeable as to transportation conditions and thus in the best position to make value judgments. Moreover, these agencies need to know about transports so that such information can be factored into emergency response plans.

It now appears that a compromise has been reached with the agreement on publication of 10 CFR Part 73.37 and of NUREG-0725 (the first of a semiannual series) by the U.S. NRC (ON80a) and the proposed application of HM-164 by the U.S. DOT. NUREG-0725 provides information on routes approved by the NRC for shipment of irradiated fuel, reported safeguards-significant incidents which have been reported and cumulative amounts of material shipped (ON80a). This report also presents the belief of the NRC that the design, construction, and use of special casks (as required by regulation) for transport of used fuels are adequate for public protection of health and safety; thus their utilization in a prescribed manner over rail and road systems designed for the appropriate weights is considered safe without specific approval of the route.

Highway routing of transport of RAM has been given considerable attention by the Department of Transportation through its development of HM-164 titled "Highway Routing of Radioactive Materials." After a development period of about

six years, these regulations are scheduled to become effective in early 1982. Of particular interest are the aspects related to special restrictions for large quantity RAM. These include preferred routes, route plans, driver training and certification, and exceptions for cargo security. A recent discussion of this development and its implications has been presented (A181).

Prenotification of shipment of RAM has been, like routing, a source of disagreement among agencies and groups having responsibilities in this area. The prime concern has been the dividing line between types of shipment for which prenotification was and was not necessary or wanted.

This issue has been resolved with the advent of recent policy decisions. These have resulted in changes in policy and procedures detailed in publications by the DOT (D081) and the NRC (ON80a),

The NRC also recently announced its change in regulations to require licensees to notify states (governors or their designated representatives) in advance when shipments of spent nuclear fuel or potentially hazardous nuclear wastes will be transported through their state, (NR80). The change will cover all such spent fuel shipments and shipments of large quantities of nuclear waste, as determined by the NRC.

The same public announcement, in the form of a news release (NR80), indicated that the NRC has affirmed in April of 1981 its confidence that its present regulations governing the transport of RAM are adequate with respect to safety. A large part of the basis for this affirmation are discussed and information contained in the "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" (OS77a).

A special feature involves handling, transport and storage of nuclear materials for weapons and weapon components. The DOE is responsible for design, testing, and manufacture of these devices to meet the requirements of the DOD. The DOD is then charged with the storage, deployment, and use, as required, of such weapons.

This aspect of transportation, by law and by mutual agreement, is the joint responsibility of these two federal agencies, DOE and DOD. It is expected that their requirements for transport and related activities will be as stringent as they would be if such materials were being handled in the general system by the usual agencies.

2.3 Regulation

One of the dichotomies in the transport of RAM which impacts especially emergency response is the fact that federal statutes assign primacy in most nuclear matters to federal agencies whereas responsibilities for health and safety are inherently assigned to the states, specifically to governors. These responsibilities sometimes tend to conflict and any real differences are apt to be exacerbated during situations which require emergency response from multiple sources, i.e. those of federal and state agencies.

Regulation of radioactive material as to its transport is based on the fact that it is a commodity in the form of a hazardous substance. Thus, regulations are based on the types of radioactive materials, their quantities, and the forms (physical forms such as solids, powders, etc.), as well as special circumstances dealing with heat generation, potential criticality, and safeguards.

Regulations are at the federal, state, and local levels. These regulations have been discussed and reviewed in several documents (OS77a, Mi80, Bai80, Ba77 and SS81a). There has been considerable activity and interest in this area in the last several years, particularly at the state and local level. The SSEB report (SS81a) gives the current status for states in the SSEB area as well as local government regulatory activities and relates the regulations to their impacts on radioactive materials transportation (i.e. their impacts as institutional barriers).

NUREG/CR-1263, "Compilation of State Laws and Regulations on Transportation of Radioactive Materials," (Bai80) describes in detail all pertinent state and local laws and regulations dealing with the transport of RAM through 1979. An especially useful part of this report is a 14-page table in the Appendix which summarizes the material in the report in a brief format.

Barker (Ba77) has summarized regulatory and other responsibilities related to transportation accidents. He describes such responsibilities as they relate to federal agencies, states, carriers, shippers, and similar groups. Regulatory activities, responsibilities for preparation for transport and for emergencies in transport are covered. This author also defines accidents in reference to the four described phases of initial, confinement, cleanup, and cost recovery.

A recent report (NE80) contains summaries of regulations from various countries dealing with transport of RAM. It

points out that national regulations have followed internationally established rules and standards. This is welcome on safety grounds and helps facilitate international transport. It notes that RAM are different from other commodities due to their potential for contamination and characteristic radiation, heat production, and criticality.

The international rules and standards referred to in the Nuclear Energy Agency (NE80) report are those of the International Atomic Energy Agency (IAEA) (IA79, Ts79) which were first published in 1961 (IA61). These basic regulations are widely followed and deal with principles, control of radiation, containment of radioactive material, safe dissipation of heat, prevention of criticality, administrative requirements for carriage and storage, and the plan for further development. A recently published review of their development and status (Fa79) indicates that IAEA regulations undergo review and revision at about 10-year intervals, which means preparations for a 1983 review are now underway.

2.4 Packaging and Handling

The primary source of control for radioactive materials while transported and handled is packaging and confinement in containers selected for this purpose. There is considerable variation in the types, amounts, and forms of radioactive materials to be transported and a consequent variety in the kinds, sizes, and materials of construction, weights, and costs of containers and other types of packaging.

Containers vary from those made of cardboard to very elaborate, heavy, lead and steel casks designed to transport millions of curies of radioactivity. The container for shipping a particular quantity and type of radioactivity is selected based on experience. The type of container as to size and construction is based upon the job to be done. The simpler containers are used for exempt materials whereas the more sophisticated containers are used to transport used fuel elements from nuclear power plants, high-level radioactive waste, certain large amounts of other wastes, and very large special sources for use in medical therapy. Table 1 is a summary of RAM packaging.

The basic purposes of the container are to confine the radioactive contents, prevent direct contact by people, and provide the shielding and geometry necessary to reduce external radiation exposures to acceptable levels at specified places which can be and are measured for compliance with regulations. See reference ON80 for yellowcake packaging requirements.

Table 1
Radioactive Material Packaging

<u>Type of Packaging</u>	<u>Requirements</u>	<u>Typical Container</u>	<u>Radionuclide Category</u>	<u>Quantity Limits</u>
non-RAM	no leakage under normal conditions	cardboard box	Limited or Exempt Quantity Low Specific Activity Radioactive Devices	0.01 mCi (TGI) -25 Ci (TGVII) 1 μ Ci/g (TGI) -0.3 mCi/g (TGIV) 1 mCi (TGI) -25 Ci (TGVII)
Type A	no loss or dispersal under normal conditions	fiberboard or wooden box, steel drum	Type A Quantity	1 mCi (TGI) -1000 Ci (TGVII)
Type B	withstand normal plus serious accident test conditions (drop, puncture, elevated temp., water submersion)	double containers (boxes, drums)	Type B Quantity	20 Ci (TGI) -50,000 Ci (TGVII)
Type B with additional provisions	Type B requirements and also greater shielding or heat dissipation	special casks, fixed to vehicle	Large Quantities	

NOTE: Based on 49CFR173.389-173.391; TG: Transport Group, see table in 49CFR173.390.

All containers used to transport radioactive material are expected to maintain their integrity during usual transport conditions and most accident situations. Type B containers are designed to withstand very severe accident stresses without loss of integrity. The general containers are designated as Type A. Each type has to undergo rigorous test conditions which are specified in regulations. Basic regulations pertaining to packaging of and containers for radioactive materials are in 10 CFR 71 and 49 CFR 127, 173 and 178. Packaging and containment are extremely important because they relate directly to the basic safety requirements for handling and transporting RAM. Safety requirements include adequate containment, adequate control of exposure, appropriate disposition of generated heat, and prevention of criticality. ✓

The rules and regulations of the NRC and the DOT are coordinated and in conformity in this area. Proposed changes first published in 1979 make the rules compatible with those of the IAEA (IA79). This aspect of transport with emphasis on waste materials has recently been reviewed (Bat80). Earlier reviews for transportation (including discussion of packaging and containers) of spent nuclear fuel and RAM have been published (SI72, SI73) by the Southern States Energy Board.

Most containers used to transport radioactive materials are handled in the conventional manner using generally available procedures, by hand, with fork lifts, and other routine handling equipment. When large and heavy casks are used for high-level radioactivity, the only special equipment is related to the size and weight of the cask.

Two types of situations require special considerations as to the packaging and handling of certain radioactive materials. The first pertains to special RAM which generate substantial amounts of heat and require heat removal systems. These materials are spent (used) fuel elements from nuclear power plants and high-level waste.

The second special category is the material for which criticality conditions could occur. This situation would normally be anticipated when certain amounts (concentrations) of fissile materials are transported. These include ^{233}U , ^{235}U , and ^{239}Pu . In these cases, special precautions are taken to preclude the concentration or accumulation of a "critical mass" of material during the handling and transport process.

Packages and containers of RAM must be properly identified by labels and/or placards. The system of identification is based on the type and amount of radioactive material; is simple in practice; and provides easy visual recognition of RAM during its handling and transport. Table 2 contains a

Table 2
Radioactive Material Labelling

<u>Label</u>	<u>Upper Exposure Rate Limit</u>	
	<u>Exposure Rate, mrem/hr</u>	<u>TI*</u>
Yellow III	200	10
Yellow II	50	1
White I	0.5	-
None**	0.5	-

* TI: Transport index; the highest radiation dose rate at a distance 3 feet from accessible external surface of package (see 49CFR173.389).

** For limited quantities of radioactive materials and radioactive devices (see 49CFR173.391).

summary of radioactive material labelling whereas more detail on U.S. Department of Transportation hazardous materials labelling and placarding requirements can be found in 49 CFR Part 172.

3.0 EMERGENCY RESPONSE

3.1 Emergencies

Radioactive materials transport accidents and incidents in the U.S. for the ten-year period 1971 - 1980 total 85 accidents in transit, 110 accidents during handling, and 464 incidents, as shown in Table 3 (Mc80). Incidents are defined as radiological problems during transportation unrelated to accidents, such as surface contamination, leaks, or insufficient shielding. This information was compiled from data accumulated in the U.S. DOT Hazardous Material Incident Report (HMIR) system; reports from NRC files since 1976 have been added. The HMIR system collects all information that must be submitted by carriers in accord with 49 CFR 171.15. These reports are required in case of death, hospitalization, property damage in excess of \$50,000, suspected radioactive contamination, or other situations that make reporting desirable, such as continued danger to life.

The HMIR and NRC information indicates that radioactive materials transport accidents have been infrequent and of minor radiological impact during the immediate past. The reported accidents and incidents average 66 per year relative to the 0.56 million (Sm76) or 2.5 million (Gr76) RAM packages shipped annually in the U.S. Radioactive materials were released from only 64 packages in 10 years. All releases were from Type A packages, and most pertained to materials such as uranium ore, uranium dioxide, low specific activity sand, and short-lived radiopharmaceuticals.

A list of the 11 accidents that involved Type B packages (Mc80) is reproduced in Table 4 to indicate the accident conditions in which larger amounts of radioactive materials were involved in the 10-year period. In none of these occurrences did the radioactive material leak from the container or radiation exposure levels increase. Two incidents involving Type B packages, however, were estimated to result in radiation exposures to humans. In 1971, high-specific-activity Mo-99 solution leaked from its container in the cargo compartment of a passenger aircraft (Gr76) with possible doses below 0.3 rem to passengers (Ta76). In 1974, an incorrectly shielded Ir-192 radiography device being

Table 3

Hazardous Material Incident Reports in 1971-1980*

	<u>No. of Accidents</u>	<u>No. of Packages in Accidents</u>	<u>No. of Package Failures</u>	<u>No. of Releases</u>
RAM transportation	85	711	41	38 (5 events)
Air	5	--	1	(1 event)
Rail	5	--	1	(1 event)
Highway	75	--	39	(3 events)
Type A	--	701	41	38 (5 events)
Type B	--	10	0	0 (0 events)
RAM handling**	110	--	--	26
Air	1	--	--	11
Rail	31	--	--	1
Highway	72	--	--	11
Other	6	--	--	3
RAM incidents †	464	--	--	50
Total hazardous material	86,500	--	--	--

* Reported by McClure and Emerson (Mc80)

** Accidents associated with storage and loading/unloading

† Not accidents; typically surface contamination report

Table 4

Radioactive Material Transportation Accidents
Involving Type B Packages*

<u>Packages</u>	<u>Date</u>	<u>Mode</u>	<u>Package Contents**</u>	<u>Accident Conditions</u>
6,000 lb cask	4/71	Rail	UF ₆	Derailment
49,000 lb cask	12/71	Truck	Spent Fuel	Truck overturned
32,000 lb cask	6/72	Truck	UF ₆	Truck overturned
15,200 lb cask	3/74	Rail	LSA	Derailment
217 lb cask	6/74	Truck	Fissile	Trailer overturned
38,000 lb cask	8/74	Truck	Waste	Trailer overturned
16,000 lb cask	8/75	Truck	U-235, U-238, Pu-239	Trailer overturned
40,000 lb cask	10/75	Truck	LSA	Tractor-trailer left road and overturned
30,000 lb cask	4/76	Truck	LSA/Waste	Truck left road and overturned
28,000 lb cylinders	3/77	Rail	UF ₆	Derailment, nearby burning NH ₄ NO ₃
6,800 lb cylinders	1/79	Truck	UF ₆	Vehicle struck in rear

* Taken from Wingert et al. (TF81); no radioactive contamination resulted from any of these accidents

** UF₆ = Uranium hexafluoride; LSA = Low specific activity

returned by the user via passenger aircraft exposed both passengers and handlers, (Gr76), the latter to a dose as high as 130 rem (Ta76).

Several other accidents have been reported. In 1970, just before the reporting program began, two trucks overturned in separate highway accidents, one carrying spent fuel in a Type B cask, the other carrying unirradiated uranium scrap (fissile material) (Gr76). No radioactive contamination or increased radiation levels were reported. Among 400,000 packages shipped through London (Heathrow) airport by the Radiochemical Centre during 1975-1980, 89 packages were damaged, but none showed any loss of radioactivity (Lo80). Forty of these packages (all Type A), however, were in a passenger aircraft that crashed and burned upon arrival at Athens airport. They were severely damaged in the fire and released some radioactivity due to temperatures that exceeded 640 °C, causing sealed aluminum cans to explode and melting the aluminum alloy in cans as well as the lead shields (Ha80). In 1974, one Type A package was loaded on an aircraft at the London airport after being crushed in handling and leaked Sr-90 silicate colloid (Lo80). In Poland, approximately 100,000 radioactive material packages were shipped in 1975, and 18 accidents occurred from 1971 to 1975 (Dy76). Three cases resulted in radioactive contamination, but none had serious radiological consequences.

Most damage to Type A packages was found to occur as a result of dropping relatively small packages from pallets, fork lifts, or carts beneath vehicles (Lo80, Gr76). The incidence of such damage was reduced at London airport by working with larger packages through overpacks and utilizing special carrying techniques such as cages instead of pallets (Lo80). Leakage of radioactive solutions from Type A packages is minimized because the vials are packed in material that absorbs the liquid, if vials break, within cans that usually remain sealed even when they are severely deformed and the outer package is breached (Lo80). The above-cited occasions of damage to vehicles without destroying the integrity of Type B packages demonstrate the resistance of these containers to ordinary traffic accident impacts.

A number of accidents and incidents in the SSEB region provided radiological emergency response experience for state and local agency staffs. Among these were the incidents of leaking Mo-99 and unshielded Ir-192 on passenger planes to Houston and Atlanta, respectively; a handling incident in 1976 at Knoxville airport, where Xe-133 gas leaked from a cracked vial so that it became unshielded although retained in the type A package (Pr80); a 1971 traffic accident in Tennessee that involved a truck with spent fuel; the 1977 derailment in North Carolina in which UF₆ cylinders were near burning

ammonium nitrate (see Table 2) (Va80, Ra79); and damage to a Co-60 teletherapy source without loss of structural integrity or increased radiation levels, on board a ship that unloaded in Savannah harbor (Be80). A report from Georgia described an overturned truck with LSA radioactive waste in sealed steel drums within a steel box on a flat-bed trailer container in August 1978 (Ca82, Ra79) and a flatbed car derailment that split open a piggy-back trailer and spilled some monazite (thorium mineral) from bags in February 1979 (Ca82). No contamination or elevated radiation levels resulted from the former, and only minor contamination, from the latter.

Many efforts are under way to estimate the risk from radioactive materials transportation (Ta80, Tv80, Ma80). These usually divide the risk into two parts -- one from accident-free transportation and the other from accidents anticipated with regard to number and type on the basis of general assumptions or past experience. In the U.S., an accident severity scheme (from the least at level one to the most severe accident at level eight) has been applied to air, truck, and rail shipments with assigned probabilities and radionuclide release fractions and patterns. For an assumed total package shipment rate of 0.56 million per year and specified distributions among radionuclides, package types, and transportation modes in the U.S. for 1975 (Sm76), the population dose equivalent was computed to be 9,600 person-rem for accident-free shipments and an additional 4.5 person-rem from accidents. Approximately 90 percent of the computed population dose from accidents was attributed to plutonium, 10 percent to radiopharmaceuticals, and less than one percent to spent fuel and radiography sources.

A separate examination of the impact of shipments in urban environs, however, suggests that if only five percent of the packages is transported through a large city such as New York, the annual risk will be 2.5 times the risk value derived above to the country as a whole (Fi80). The risk due to assumed accidents in transporting only spent fuel and radioactive waste from nuclear power plants in the U.S. had earlier been estimated to be very small with regard to either contamination or exposure (RS72). Population doses were computed for the accident-free case, but were not given for accidents.

To assist in considering the possible impact of transportation accidents that involve radioactive materials, several scenarios have been postulated (Al79). Dose rates are given as a function of distance from the scene of the accident. The report concluded that radiological effects will be small in most cases.

3.2 Responsibilities

Planning for and responding to RAM transportation accidents has involved participation by local, state, and federal agencies, the shipper of the material, and the carrier. Local and state agencies generally are legally responsible for handling such accidents in the U.S. (Va80, TF81). Several designated federal agencies provide guidance for program planning in accord with 44 CFR 351 and support for incident response if requested. Competent response to incidents by carrier personnel and prompt response by the shipper to requests for information and logistical support concerning the involved material can assist greatly in dealing with such accidents or incidents.

The basic planning document for responding to RAM transportation accidents is the state Transportation Radiation Emergency Response Plan (TRERP). It assigns responsibilities among local and state officials and identifies the persons and organizations to be contacted in case of accident. In most states, the TRERP is part of the state-wide Radiological Emergency Response Plan or Emergency Operations Plan (Mi80). Preparation of these plans has been stimulated by NRC requirement of a Radiological Emergency Response Plan in support of nuclear power plants (Gr80) in states where such plants are located. A survey completed in mid-1980, however, found that 13 states had no documentation for a TRERP (Mi80).

Guidance for preparing state TRERPs came initially from the Western Interstate Nuclear Board (WI75). Currently, a task force on transportation incidents under policy direction by the Federal Radiological Preparedness Coordinating Committee is developing a guide, which is being circulated in draft form (TF81).

Assignment of responsibility for handling RAM transportation accidents depends crucially on the availability of professionals and trained staff with competence in radiation protection. The 1980 survey (Mi80) found in 26 states of 48 responding that no jurisdictions within the state could exercise their own authority, i.e., the state government was responsible. Selected local jurisdictions -- usually large cities with adequate radiological response capabilities -- have authority to respond in five states, and all local jurisdictions have authority to respond in the remaining 17 states.

In the SSEB region of 16 states and Puerto Rico, 13 state governments currently participate in the Southeastern Mutual Radiation Assistance Plan (SMRAP) (SE81). The plan was developed by the Southern Emergency Response Council. It

provides for information exchange among the states and assistance upon request. Information exchange concerns the following important aspects of radiological emergency response:

emergency teams	communications	medical facilities
equipment	transportation	public relations
laboratories	civil defense	protective action guides

Ten federal Interagency Regional Advisory Committees and one Headquarters Advisory Committee are available to assist states in preparing Radiological Emergency Response Plans and exchanging information concerning federal, state, and local capabilities for emergency response within regions (Va80). Federal agencies such as FEMA, DOE, NRC, EPA, and DOT are members of these committees.

The Interagency Radiological Assistance Plan (IRAP) provides the mechanism for assisting in radiological emergencies upon request by state and local agencies (Va80). Primary means of support are trained radiological emergency response teams that can be dispatched on brief notice from numerous federal installations. In the SSEB region, such teams are available at Aiken, SC (SR81), Oak Ridge, TN (DE79) Upton, NY (ED75), and Albuquerque, NM (ED75a, ED76, ED76a), from the DOE; at Muscle Shoals, AL from TVA; at Montgomery, AL from EPA; and at Atlanta, GA from NRC (SE81).

Recommended activities by shippers and carriers in response to RAM highway transportation accidents are presented in an ANSI standard now in draft form (AN80). The draft standard specifies the carrier's driver, dispatcher, and management responsibilities for planning, training, promptly notifying the emergency response agency and taking accident control measures. Emergency response preparation and assistance measures by the shipper are also presented. The carrier has legal responsibility for reporting accidents and incidents to DOT, but this responsibility is distinct from initiating accident control by notifying the emergency response agency.

3.3 Preparedness

Response to RAM transportation accidents is organized state by state on the basis of its TRERP. Federal guidance for preparing and evaluating a TRERP is now in draft form (TF81), and further guidance may be obtained in reports from the IAEA (Be80, IA81), Britain (B180), and Canada (Mc77). Major planning items for states based on these guides are (1) coordination among the various agencies participating in

emergency response; (2) designation of lead agency and on-scene coordinator; (3) training and field tests of responding staff in radiological protection and emergency response; (4) availability of equipment; (5) means of transportation and communication for prompt response; (6) arrangements for support in health physics, medicine, and emergency control; and (7) provision for giving accurate information to the governor's office and news media. Prior preparations concerning all of the above items are especially important because most states have limited resources in trained staff and appropriate equipment.

The state agencies participating in response to RAM transportation accidents usually include those responsible for public health, radiation control, emergency management (e.g., civil defense), public safety, and environmental protection. One or the other among these is usually the lead agency for radiological emergency response (Mi80). In response to the 1980 questionnaire, 33 states and Puerto Rico reported that they pre-designate on-scene coordinators, and the remainder have less formal arrangements, are in the process of developing arrangements, or have no such designation (Mi80).

Ongoing training programs are needed because most personnel participating in emergency response -- notably those from law enforcement agencies and fire departments who are generally first on the scene -- with active roles to play have no professional background in radiation protection. Conversely, radiation protection specialists often are not experienced in dealing with radioactive sources in the context of other hazards, such as fire, explosion, corrosive liquids, or poisonous gses, and with caring for injured persons or controlling crowds. Workers who handle RAM shipments and medical staffs that may assist accident victims also need training for responding promptly and effectively in radiological emergencies.

Only realistic field exercises can test the effectiveness of planning and training (Va80). Large-scale tests are particularly important to assure that personnel from different agencies and with different professional backgrounds and levels of training are cooperating according to plan.

Short courses on RAM accident response are presented by several federal agencies (Va80, TF81) and other organizations (Th80), and applicable training material has been distributed (Ra79). In response to the 1980 questionnaire, most states indicated ongoing training for its personnel, notably through radiological emergency response operation (RERO) and radiological defense (RADEF) programs (Mi80). Drills to test response capability have been performed in many, but not all

states. Some rely on responses to actual incidents to test their effectiveness. The survey report concluded, however, that frequent misuse or lack of proper maintenance of radiation detection instruments by first responders indicates a deficiency in training, and that officials complained of inconvenient scheduling and long waiting times for courses (Mi80). A major problem in maintaining the desired level of trained staffs in responding organizations is personnel turnover.

FEMA and other federal agencies preceding it have supplied the states with many radiological survey instruments (SE81). Responses to the questionnaire indicate that simple survey instruments are widely distributed within states (Mi80). The more complex and specialized the instruments, however, the fewer are available and the less widely distributed they are. A few states report that they lack some survey instruments and associated monitoring equipment, including entire emergency response kits. Instances of inadequate maintenance were cited, as mentioned above.

Means of transporting responding staff to the scene of the accident and of communication networks to support accident response were reported to be available to all state agencies that answered the questionnaire (Mi80). Transport included aircraft, boats, and specialized vehicles in addition to cars. Vehicles may be provided by the participating agencies, motor pools or support agencies. Some agencies have designated emergency vehicles, including specially furnished radiation emergency response vans. The available communication system in most instances is the state police radio. A mobile emergency communications vehicle is available in many, but not all, states.

In serious accidents, state or local officials may need professional assistance by more radiological physicists than are employed in their agencies, and cooperation by staffs at medical facilities to treat injured persons that may be contaminated with radioactivity. Support by other states and the federal government can be obtained as indicated in the preceding section. Response agencies in most states maintain rosters of radiological health specialists in universities, industry, or government to call upon for assistance as needed (Mi80). A majority of states identify hospitals that are prepared to receive contaminated patients, but in some states this arrangement is informal and in other states no information is available.

The state executive and the public must be informed of the extent of the accident to take appropriate protective actions in the event of a hazard, be reassured in the absence of hazard, and in all cases to support accident responses and

prevent interferences. Guidance on this topic emphasizes factual reporting, clear communication, defined lines of responsibility, selection of a single spokesperson to the media with competence in the topic under discussion or a close advisor with this competence, and rumor control (TF81, Wa80). The responsible officials are usually faced with demands for prompt evaluation of the accident situation on the basis of incomplete information; relatively widespread fear of radioactivity hazards when an accident is reported but no details are available; and with pressure on or temptation of various participants to provide partial information that may be highly misleading.

3.4 Response

Handling of RAM transportation accidents has been divided into three phases -- initial, evaluation, and cleanup -- for purposes of planning (IA81). The general preparedness needs considered in the preceding section pertain to all three phases, but a number of guides indicate the different approaches required during the three phases (TF81, Gu81, IA81, Be80).

The main burden in the initial phase is on the carrier employee -- e.g., the driver -- and the first official responder -- usually a law enforcement officer or firefighter -- to render first aid to the injured, prevent the situation from becoming worse both radiologically and with regard to other hazards, and to notify radiological and other needed emergency response staff. The DOT has published a hazardous materials emergency guidebook for placing in emergency response vehicles to assist in the initial phase (D080). The guide shown in Table 5 is typical of guides No. 61 - 66 which pertain to radioactive materials. The same purpose is served by guides prepared by state agencies, such as the one in Table 6 distributed by the Georgia Environmental Radiation Program; this guide also has separate one-page instructions for law enforcement officers and for firefighters. The ANSI standard for emergency response procedure involving truckload quantities of RAM includes detailed guidance for the driver (AN80). It recommends actions necessary to control the accident situation, advise others on the scene, notify local authorities, and contact the dispatcher. The conclusions reached by the first persons on the scene may determine the magnitude of the next phase, which can range from involvement by one radiation protection professional to massive response by numerous agencies.

In the evaluation phase, the on-scene coordinator, assisted by specialists, must definitely determine the

Table 5

Potential Hazards Guide 63*

HEALTH HAZARDS

Radioactive Material -- Degree of hazard will vary greatly depending on radioactive material.

External radiation from unshielded radioactive material.

Internal radiation from inhalation, ingestion or skin absorption.

Runoff from fire control or dilution water may cause pollution.

FIRE OR EXPLOSION

Some of these materials may burn but do not ignite readily.

EMERGENCY ACTION

Keep unnecessary people at least 150 feet upwind; greater distances may be necessary if advised by Radiation Authority.

Isolate hazard area and deny entry.

Enter spill area only to save life; limit entry to shortest possible time.

Wear positive pressure breathing apparatus and full protective clothing.

Detain persons and equipment exposed to radioactivity until instruction or arrival of Radiation Authority.

Delay clean-up until arrival or instruction of qualified Radiation Authority.

FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800)424-9300.

Also, in case of water pollution, call local authorities.

FIRE

Do not move damaged containers; move undamaged containers out of fire zone.

SMALL FIRES: Dry chemical, CO₂, water spray or foam.

LARGE FIRES: Water spray or fog (flooding amounts).

For massive fire in cargo area, use unmanned hose holder or monitor nozzles.

Fight fire from maximum distance.

SPILL OR LEAK

Do not touch damaged containers or spilled material.

Damage to outer container may not affect primary inner container.

Small Liquid Spills: Take up with sand, earth or other noncombustible absorbent material.

Large Spills: Dike far ahead of spill for later disposal.

Table 5 (continued)

FIRST AID

Call emergency medical care.

If not affecting injury, remove and isolate clothing and shoes; wrap victim in blanket before transporting.

If not injured, remove and isolate contaminated clothing and shoes; shower victim with soap and water.

Except for the injured, detain persons and equipment exposed to radioactivity until instruction or arrival of Radiation Authority.

Advise medical care personnel that injured persons may be contaminated by radioactivity.

* Taken from Hazardous Materials 1980 Emergency Response Guidebook (D080).

Table 6

General Guidance for Immediate Actions in the
Event of a Radiation Incident by the First
Individuals on the Scene*

1. Keep all persons as far away as possible from the incident scene.
2. Perform any life saving rescue and first aid necessary.
3. If there is a fire or danger of fire, summon assistance from the nearest fire department.
4. Keep upwind of the incident, especially when fire is present.
5. Notify the Georgia Environmental Protection Division as soon as possible (24-hour number--(404)656-4300). Provide information outlined on the Information Recording Form.
6. Avoid contact with radioactive materials and suspected contaminated material.
7. Detain all persons involved with the incident or potentially contaminated by the incident, except injured individuals, at the scene until the Radiological Emergency Response Team arrives.
8. Record names, addresses, destinations, and phone numbers of any persons who cannot be persuaded to stay at the incident scene.
9. Eating, drinking, and smoking in the incident area shall be prohibited.
10. Remain calm and wait for the arrival of the Radiological Emergency Response Team.

* Taken from Radiation Emergency Information (ER80).

magnitude of the accident and initiate suitable protective measures. The extent of the radiological problem is determined from information concerning the RAM in shipping papers, on labels, from the shipper, from observing the condition of the package, and by monitoring for radiation exposure rate and radionuclide contamination.

The following broad categories may be encountered:

1. False alarm. A radiation problem is wrongly inferred from observations such as wet surfaces on a package (Pr80), erroneous reading (or interpretation of reading) with a radiation detector (Lo80), or open packages falsely labelled as containing radioactive materials.

2. Damaged RAM package but no release of radioactive material or elevation of radiation dose rate. An incident or accident occurs but there is no radiation problem.

3. Limited radiological problem. Some escape of radionuclide from container and/or some elevation in radiation exposure rate occurs, but there is no significant hazard to persons or need for restricting access to large areas.

4. Serious radiological problem. Persons are significantly exposed to radiation or the situation holds the potential for such exposure.

These categories are compounded by nonradiological problems resulting from the accident and by the presence of other hazardous material.

If there is no radiological problem (categories 1 or 2), then the response moves to the cleanup phase for both the radioactive material package and any associated accident debris. If a problem exists (categories 3 or 4), the response could range from minor area restriction and continued surveillance to invoking extensive support in personnel and equipment, restricting large areas, and maintaining numerous contaminated or exposed persons under care, control or observation.

When serious exposures exist, guidance is needed to determine acceptable exposure and contamination levels for protective action and for decontamination to return persons, areas, and materials to normal activities. The EPA has undertaken the task of recommending such levels, and has published draft protective action guides (PAGs) for whole body exposure to airborne radioactive materials and for exposure of the thyroid to inhaled radioiodine (OR80).

In the cleanup phase, the RAM is sent on its way if there was no problem, returned to the shipper (repacked if the

package was damaged), if no leakage occurred, or disposed of in accord with regulations if the radioactive materials leaked from the container. Materials made radioactive must also be disposed of or decontaminated to the extent considered acceptable. Persons, areas, and materials must be monitored to assure absence of excess radioactivity. The situation must be reported and documented in sufficient detail to define elevated radiation doses to exposed persons and assure the absence of exposure when none occurred.

4.0 THE SSEB REGION

4.1 State Response Plans

All sixteen states in the SSEB region (but not Puerto Rico, which is included in the region) have developed systematic response plans for radiological emergencies, emergency operations, or disasters, as shown in Table 7. These plans have been prepared very recently, and many are still under development. In most states the TRERP is part of the overall plan but is addressed in a separate chapter, annex, or appendix.

With the exception of Mississippi's, these plans have been made available by the state agency and placed in the SSEB library. The Mississippi plan is being prepared, and approximately one-half of the completed plans are under revision to the extent that the available document will have to be replaced. The survey presented in Table 7 and Appendix A is based on the plans available to this study in the SSEB library, and on telephone inquiries addressed to state officials associated with plan preparation and execution.

Responsibilities for the overall emergency response plan vary greatly among states with regard to both lead agency and participating agencies. This would be expected because of the widely different ways in which state governments are organized. Moreover, the concept of a separate agency responsible for disaster control has been followed at the federal level only recently with the organization of FEMA. States have just begun matching this organizational pattern.

State radiological protection officials usually are responsible for radiological emergencies at fixed facilities and during transportation because of the specialized competence needed in dealing with resulting problems. These officials are assigned to various agencies in the several states, notably those concerned with public health and

Table 7

Transportation Radiation Emergency Response Plan (TRERP) in SSEB Region

<u>State</u>	<u>Name and Date of Most Recent Emergency Plan</u>	<u>Availability</u>	<u>TRERP</u>	<u>Responsible Agency for TRERP</u>	<u>Official in Charge of Updating Plan</u>
ALABAMA	Radiation Emergency Plan; 2/16/78	SSEB Library	Annex B	Dept. of Public Health, Radiological Health Div.	Aubrey V. Godwin, Director, Div. of Radiological Health
ARKANSAS	Emergency Operations Plan, 12/79	SSEB Library. Current plan is under revision.	Radiological Incident Response Annex Q	Dept. of Health, Bureau of Environmental Health Services, Radiological Health Div.	E.F. Wilson, Director, Div. of Environmental Health Protection Services
FLORIDA	Radiological Emergency Assistance Plan for Incidents other than Fixed Nuclear Facilities (REPO), 12/79	SSEB Library. Current plan is under revision.	Included in REPO	Dept. of Health & Rehab. Services, Dept. of Community Affairs, Disaster Preparedness Div.	Uray Clark, Administrator, Radiological Health Program
GEORGIA	Radiological Emergency Plan, 12/79	SSEB Library	Transportation Accident Response, Annex H	Dept. of Natural Resources, Environmental Protection Div.	Environmental Radiation Program Manager
KENTUCKY	Natural Disaster Plan, 4/80	SSEB Library	Hazardous Materials, Annex Q	Dept. of Military Affairs, Div. of Disaster and Emergency Services	Donald R. Hughes, Manager, Radiation Control Branch

Table 7 (cont'd)

<u>State</u>	<u>Name and Date of Most Recent Emergency Plan</u>	<u>Availability</u>	<u>TRERP</u>	<u>Responsible Agency for TRERP</u>	<u>Official in Charge of Updating Plan</u>
LOUISIANA	Preparedness Plan for Emergency Operations, 9/78	SSEB Library	Peacetime Radio- logical Response Plan, Annex J, Appendix 7; separate plan is being developed	Dept. of Natural Resources, Office of Environmental Affairs, Nuclear Energy Div.	William H. Spell, Administrator, Office of Environ- mental Affairs Nuclear Energy Division
MARYLAND	Disaster Assistance Plan, 1980	SSEB Library. Plan is out of date, new plan not yet received.	Radio- logical Emergency Response Plan, Annex Q	Dept. of Emergency Management and Civil Defense	Robert E. Corcoran, Chief, Div. of Radiation Control
MISSIS- SIPPI	Emergency Operations Plan	Nothing avail- able. New plan is being formu- lated, but has not been received.	Radio- logical Emergency Response Plan, Volume 5	State Board of Health, Div. of Radiological Health	Eddie S. Fuente, Director, Division of Radiological Health
MISSOURI	Emergency Operations Plan, 5/79	SSEB Library	Part 3, Radio- logical Emergency Assistance Plan	Dept. of Public Safety, Disaster Planning and Operations	Kenneth W. Miller, Administrator, Bureau of Radiological Health

Table 7 (cont'd)

<u>State</u>	<u>Name and Date of Most Recent Emergency Plan</u>	<u>Availability</u>	<u>TRERP</u>	<u>Responsible Agency for TRERP</u>	<u>Official in Charge of Updating Plan</u>
NORTH CAROLINA	Hazardous Materials Emergency Response Plan, 2/81	SSEB Library	Included in HMERP	Dept. of Crime Control and Public Safety, Div. of Emergency Management	Dayne H. Brown, Chief, Radiation Protection Section
OKLAHOMA	Natural Disaster Plan - Health Annex, 1976	SSEB Library	Not included in NDP. It is 4 page internal Dept. of Health document, 12/20/78	Dept. of Health, Office of Occupational and Radiol. Health Service	Dale McHard, Chief, Occupational & Radiological Health Service
SOUTH CAROLINA	Operational Radiological Emergency Response Plan, 8/81	SSEB Library	Included in ORERP, 2/82	Dept. of Health and Environmental Control, Bureau of Radiological Health	Heyward G. Shealy, Chief, Bureau of Radiological Health
TENNESSEE	Disaster Assistance Plan, 11/79	SSEB Library. This plan (Appendix II to Annex II-i) is void. New plan not yet received.	Emergency Procedures for Radiol. Incidents at Fixed Facilities and in Transportation, Appendix II to Annex II-i	Dept. of Public Health, Div. of Radiological Health	J.A. Bill Graham, Director, Division of Radiological Health

Table 7 (cont'd)

<u>State</u>	<u>Name and Date of Most Recent Emergency Plan</u>	<u>Availability</u>	<u>TRERP</u>	<u>Responsible Agency for TRERP</u>	<u>Official in Charge of Updating Plan</u>
TEXAS	State Disaster Plan, 9/78	SSEB Library. This plan is out of date. New plan (Appendix VII) not received.	Radiological portion, Annex L, Appendix 12, Tab 1.	Dept. of Health, Occupational Health and Radiological Control Division	Branch Administrator, Emergency Response and Investigation Branch, Division of Compliance and Inspection, Bureau of Radiation Control
VIRGINIA	Emergency Operations Plan, Radio- logical Emer- gency Response Plan Annex I-V to Vol. II, 4/81	SSEB Library	Appendix 14, Transportation Accidents	Office of Emergency and Energy Services, Disaster Preparedness Branch	Ernest S. King, Chief, Planning Division, Office of Emergency and Energy Services
WEST VIRGINIA	Emergency Disaster Plan of 1978	SSEB Library. Current plan is under revision.	General plan, does not spec- ifically ad- dress tran- sportation accidents	Office of Emergency Services, Dept. of Health, Industrial Hygiene Div.	William H. Aaroe, Director, Industrial Hygiene Division

environmental protection. Officials from disaster response agencies are formally involved in some of the plans. From a practical point of view, their participation is important when the transportation radiological emergency is serious -- category (4) in Section 3.4 -- or other hazards are involved. When the radiological problem is minor or does not exist, response by a professional in radiological protection is usually all that is appropriate and necessary.

Some of the relatively recently prepared radiological emergency response plans -- notably the Georgia plan -- are models of detailed information. They designate responsibilities, present protection action guides, consider probable scenarios and appropriate responses, and specify a wide range of support actions and activities leading to a return to normalcy. On the other hand, several of the plans are organized so confusingly that it is difficult to visualize their being used in an emergency, and others have much ancillary information but little guidance for radiological emergencies. The latter are generally those under extensive revision.

Some of the items of information identified in the Introduction are summarized in Appendix A for each state plan to indicate what is available and where further information is desirable. Information concerning regulations, agency responsibilities, communications, and public information procedures (items 1, 2, 4 and 5) are generally presented in the plans. The only broadly operative interstate agreement (item 6) is the Southern Mutual Radiation Assistance Plan, although Virginia, West Virginia, and Maryland are states that do not participate. Maryland reports an interstate agreement with the District of Columbia and discussions of other agreements in progress. Several other states make provisions for notifying contiguous states as appropriate.

Lists of qualified individuals that could provide radiological competence (item 3) are presented in only a few plans. When available, the lists do not all indicate the specific competence nor the telephone number for reaching the individual. It was noted that even in the best plans, many of the names and telephone numbers of staff, agencies, and supporting specialists were outdated due to changes in responsibilities, locations, or telephone numbers.

Relatively little specific information was available in most plans concerning training activities and manuals (items 7 and 8). Availability of training courses and training materials sponsored by DOT, DOE, and NRC have been cited in Section 3.3 (Va80, TF81, Ra79).

4.2 Carrier Response Plans

Carriers are responsible for radioactive materials during the time they are in their possession. They may also be the most vulnerable due to the fact that their primary interest and experience are in transporting commodities. Thus, those that handle and transport RAM need special training and preparation in this area.

The principal carriers have prepared themselves and their employees, particularly drivers, through use of educational materials and available training. Examples of educational materials can be found in publications such as "Radioactive Materials Transportation Manual" (TS78), "Driver Instruction Safety Manual" (TS79), "Field Supervisor and Senior Technician Training Manual" (Co78), "Hazardous Materials - Acceptance and Handling" (Ea77), and "Restricted Articles Handling" (De77).

The first two publications are those of Tri-State Motor Transit Company which specializes in transport of RAM by highway. It possibly is the largest RAM carrier. These manuals contain relevant background information, training materials, and emergency response procedures.

Co78 is a training manual published by Chem-Nuclear Systems, Inc., for its employees. This multi-purpose company is a carrier, shipper, and operator of one of the three operational shallow land burial sites for low-level radioactive waste in the U.S. (CN78, CN80). The other publications, Ea77 and De77, are those by Eastern Air Lines and Delta Air Lines, respectively. These latter two instructional materials are not as extensive as the others but serve as guidance for the company's employees. These latter carriers tend to augment their staffs by use of reputable consultants as the situation warrants.

Little information was provided by railroads in the area of general background material and employee training to cope with transport and accidents involving RAM. Most indicated a general posture of depending on consultants, employed as needed, or on federal agencies that have responsibilities for emergency response to transportation accidents.

Thus, the expertise available from carriers to cope with transportation accidents involving RAM is uneven. It varies from the well prepared, in terms of trained personnel, know-how, equipment and supplies, to those with apparently little interest, capability, or ability.

To obtain and maintain proficiency in controlling problems encountered in the transport of RAM it is necessary

to train the appropriate individuals periodically and systematically. The larger companies tend to train their own employees whereas the smaller ones utilize available training programs. Programs available in 1980 were catalogued by Thompson (Th80). This listing covers training sponsored by federal agencies, federal contractors, private companies, and academic institutions.

Impetus for adequate training comes from regulatory requirements. The requirements of the Department of Transportation for driver training were outlined in amendments published in the Federal Register on January 13, 1981, (D081) entitled "Radioactive Materials; Routing and Driver Training Requirements." The effective date of these requirements was February 1, 1982.

4.3 Response Capabilities

Every state in the SSEB region has the capability for managing accidents and incidents associated with RAM transportation, as demonstrated in their responses to such situations over the years and described in the radiological emergency response plans. The current status of these capabilities and needs for improving them were discussed in detail at two workshops held by SSEB in 1980 and 1981 (SS80, SS81). Participants identified some of the improvements resulting from recent developments, significant differences from the responses for fixed facilities which are being given priority consideration, and items for which relatively modest efforts could yield important benefits.

Response planning for RAM transportation emergencies has been strengthened considerably by the mandated development of state TREP's; by regulations in several states that require shippers of large RAM amounts to notify state agencies of amounts, routes, and schedule; and by studies of RAM transportation supported by DOT and NRC in several states (Ca79, Ca81, Ca81a, KY80, SC80) and ongoing in South Carolina, Kentucky, and Florida in the SSEB Region. The plan provides a systematic program in each state for responding and for developing and improving this capability. Notification of RAM shipments will, for the first time, inform the state on a regular basis how much RAM of the specified large amount is being shipped, where the radioactive materials are being carried, and who is carrying them. The studies of RAM shipments examine compliance with packaging, labelling and shipping regulations --the main technique for preventing incidents -- and have recommended improvements where needed.

Staff members of state agencies responsible for dealing with RAM transportation emergencies in the SSEB region confirm the observations based on national reports to DOT (Mc80) that few incidents occur in any year, and that by far the greatest number of responses are to minor incidents. Many notifications are false alarms, and most of the others are cases of damage to packages or containers without elevated radiation exposures or release of radioactivity. The incidences of elevated radiation or radionuclide levels have been of the order of one per year or less for individual states. Most of the states do not appear to have experienced a RAM transportation accident that called for major response efforts, and elevated levels were not found where such responses were needed.

Effective response to these minor incidents that are the most common of RAM transportation emergency situations requires prompt notification by the shipper's employee of the designated state agency and prompt response by agency personnel competent in radiological protection. The driver or handler must be alert for elevated radiation or radionuclide levels due to damages or imperfections, immediately isolate the problem container, and contact the indicated response group in the state. The responder must be able to reach the site within a few hours, measure reliably the radiation and radionuclide levels due to natural background, undamaged RAM, and the problem container, and reach a decision concerning the extent of the problem. Hence, the shipper's employees need at least a brief training course, a simple guide such as the ones issued by several states and DOT, and the correct telephone number for the state agency. The state agency needs either trained staff throughout the state or rapid transportation for centrally located professionals, with sufficient monitoring instruments in good working order and accessible laboratory support to provide the data for decision making.

Workshop participants emphasized the desirability of frequent training courses within each state for local response personnel and an improved distribution system for brief guides to assure that they are placed in the hands of RAM drivers and initial responders to accidents. Difficulties on the part of shipper's employees in notifying the appropriate agency personnel due to changes in staff, assignments, and telephone numbers were reported. Maintenance of radiation detection equipment kept at locations throughout the state out of the control of radiation protection staff is difficult, as indicated in a national survey (Mi80). Poor maintenance or incompetent use of such instruments have been known to cause interference with shipments, blocking traffic, and generating fear.

Although their incidence is rare, a state agency needs to prepare for serious cases of radionuclide contamination or

elevated radiation resulting from transportation accidents. In states that have nuclear power plants, the field exercises and associated planning for controlling accidents at fixed sites are also useful preparation for transportation accidents. Two drawbacks were noted concerning the results of such exercises:

1. The Protective Action Guides developed by EPA are woefully incomplete because they pertain to only two of many potential circumstances.

2. The critiques following field exercises are not adequate for improving the state program.

A few training exercises have been held to practice for transportation accidents, for example by TVA for radioactive waste shipments by truck. Among important differences between transportation accidents and those fixed facilities is the former has the potential for mixed hazardous materials shipments and could occur almost anywhere. These possibilities require much broader and more wide-spread preparations for early responders such as law enforcement officers and firefighters, and in support facilities such as hospitals. It was noted, for example, that difficulties have been encountered in gaining admission for the injured to emergency wards if the extent of their radioactive contamination was in question.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Despite the extensive transport of radioactive materials, accidents and incidents are rare. During the past ten years, total reported accidents plus incidents averaged 65 per year in the U.S. of which one-sixth resulted in radionuclide releases. The primary means of preventing incidents of releases and minimizing the effects of accidents in causing releases is regulatory control by DOT to assure appropriate packaging, labelling, and handling of radioactive materials.

Considerable efforts have been devoted recently to reducing the potential for hazard even further by strengthening the emergency response capabilities of the states. These efforts include preparation of state transportation radiation emergency response plans; supporting the response capability with equipment and supplies, training courses and manuals, and response teams from federal agencies and neighboring states under joint cooperative programs; and limiting transport

routes while requiring shippers to notify state agencies concerning major shipments.

This examination of the status of transportation radiation emergency response in the SSEB region of sixteen states has found response planning and capability in each state. Both differ widely among states in format and extent, according to the published plans and discussions held in two workshops.

The following recommendations are based on the available information and on suggestions made by participants in the two workshops:

1. A state transportation radiation emergency response plan is desirable for planning an effective program and coordinating efforts by contributing agencies within a state. A model plan should be developed to assist states that have only a general disaster plan or radiation emergency plan.

2. The Southeastern Mutual Radiation Assistance Plan is the only formal mechanism for mutual support in this type of emergency for most states in the region. A detailed program for cooperative training, exercises, and responses by neighboring states should be developed so that the plan can be translated into practical cooperation and support.

3. Broadly accepted Protective Action Guides are required for making decisions during and after an emergency. Additional PAG's should be developed beyond the two now recommended by EPA for considering external radiation during rescue and cleanup, consumption of contaminated food and water, surface contamination, and external radiation from materials after decontamination.

4. A comprehensive medical protocol is required to gain prompt admission to hospitals for persons who have been involved in transportation accidents. This is needed to prevent delay due to the question of radioactive contamination when such contamination is trivial or absent, while preventing unacceptable contamination levels in medical facilities.

5. Frequent radiological training courses on an elementary level are needed within each state to maintain the competence of first responders despite rapid personnel turnover.

6. The system for distributing information and guidance for handling radiation accidents and incidents should be improved to assure that telephone numbers and other relevant information for notification are current and that potentially involved persons have instruction manuals.

7. Several options are available to states for assuring prompt response to emergencies. For example, responsibility and supporting equipment may be centralized or at a local level. If centralized, fast transportation and a good field communication system must be available; if localized, more detailed training and good equipment maintenance must be undertaken. Such options and their implications should be explored to assist state agencies in making choices for response.

8. A systematic effort needs to be made to identify, locate, inventory, and evaluate technical support available in the private sector which could be used in case of serious transportation accidents or one in which the needed response is prolonged.

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7.0 APPENDIX

Information for states' Transportation Radiation Emergency
Response Plans in the SSEB Region.

Appendix A-1

ALABAMA

1. Enabling legislation and regulations.

Alabama Civil Defense Act, E.O. #14 dated June 19, 1971.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

Health Department and Civil Defense Department have primary responsibilities. Other responsible agencies are the Departments of Agriculture and Industries, Public Safety, Pensions and Security, the State Highway Department, Alabama National Guard, and the Department of Conservation. Detailed account of responsibilities appears on pages 9-10 of the plan.

3. List of qualified individuals (or pages in plan which list).

Individuals are listed on pages B-11 through B-14. No qualifications are given.

4. Communications for sounding the alarm, informing the related agencies.

Procedure for notification in Appendix B-1 of plan.

5. Public information spokesperson.

The State Health Officer or the Governors Office shall release necessary information to the public through various news media.

6. Interstate agreements.

Contact Georgia and Florida in the event of a power plant incident. Page B-3a gives details.

7. Availability of training (organizations).

Training is outlined on page B-2 and Appendix VIII. State Department of Health and Nuclear Facility operators give separate seminars at least annually.

8. Available training manuals.

No manual was cited.

Appendix A-2

ARKANSAS

1. Enabling legislation and regulations.

Arkansas Emergency Services Act 511 of 1973, Act of 8 of 1961 (State Control Act), Governors Directive "Emergency Assignments and Procedures."

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

Local governments have the major responsibility. If their resources are inadequate they contact state government's Office of Emergency Services. Responsibilities are assigned as appropriate to a given situation. Pages Q6-Q8 list responsibilities in detail.

3. List of qualified individuals (or pages in plan which list).

No names or qualifications are given.

4. Communications for sounding the alarm, informing the related agencies.

Procedure for notification appears on pages 12-13.

5. Public information spokesperson.

Radiological Response Team Captain.

6. Interstate agreements.

None mentioned.

7. Availability of training (organizations).

Short course given on "Management of Radiation Accidents", then refresher courses are given. Also, technical training is given to response teams, including a simulated incident at least once every 5 years. Chapter 8 in the plan gives a detailed description of training.

8. Available training manuals.

No manual was cited.

Appendix A-3

FLORIDA

1. Enabling legislation and regulations.

Chapter 252 Florida Statutes and Governor's Executive Order 76-6.

2 Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The Department of Health and Rehabilitative Services is the lead agency. The Division of Disaster Preparedness, the Department of Highway Safety and Motor Vehicles, the Highway Patrol and local state agencies all have supportive roles. Responsibilities are specified on pages 2-3.

3. List of qualified individuals (or pages in plan which list).

No names or qualifications were given.

4. Communications for sounding the alarm, informing the related agencies.

Communications for informing related agencies and their personnel are as given on pages 3-5.

5. Public information spokesperson.

Control of official release to the news media of all information from a state agency will be exercised by the Governor or his designated representative. Responsibility of media releases to determine validity of information and accuracy of technical data rests with the Department of Health and Rehabilitative Services, Central Operation Services.

6. Interstate agreements.

None mentioned.

7. Availability of training (organizations).

None mentioned.

8. Available training manuals.

No manual was cited.

Appendix A-4

GEORGIA

1. Enabling legislation and regulations.

Civil Defense Act of 1951, Governor's E.O. February 8, 1978, Governor's E.O. April 5, 1979, Georgia Natural Disaster Operations Plans, Radiation Control Act, Water Quality Control Act of 1974, Air Quality Control Act of 1978, Transportation of Hazardous Materials Act of 1979.

2. Participating agencies and their responsibilities, title to each administrator, (or pages in plan that have a title listing).

- a) Georgia Department of Natural Resources, Environmental Protection Division -- see page 10 for responsibilities.
- b) Georgia Department of Defense (Civil Defense Division) --see page 10 for responsibilities.
- c) Georgia Department of Public Safety -- see page 11 for responsibilities.
- d) Georgia Department of Transportation -- see page 12 for responsibilities.
- e) Georgia Department of Agriculture -- see page 12 for responsibilities.
- f) Georgia Department of Human Resources -- see page 12 for responsibilities.
- g) Georgia Game and Fish Division -- see page 13 for responsibilities.
- h) Georgia Forestry Commission -- see pages 13-14 for responsibilities.
- i) Georgia Local Agencies -- see pages 13-14 for responsibilities.

3. List of qualified individuals (or pages in plan which list).

See pages 5-8 for listings of individuals -- qualifications are not mentioned.

Appendix A-4 (continued)

4. Communications for sounding the alarm, informing the related agencies.

Prodedure for notification appears on pages 1-2.

5. Public information spokesperson.

The local Emergency Operations Center (EOC) will keep public informed through the information officer as designated by the State Emergency Coordinator.

6. Interstate agreements.

State Radiological Program Directors of states that may be affected are to be notified as soon as practical following a radiological emergency.

7. Availability of training (organizations).

Environmental Protection Division presents periodic lectures, training, and exercises -- see page 18 for details.

8. Available training manuals.

No manual was cited.

Appendix A-5

KENTUCKY

1. Enabling legislation and regulations.

Enabling legislation and regulations are not mentioned within Annex Q.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

Local government, in coordination with appropriate state and/or federal officials, will respond to an incident. If local authorities are unable to cope with the incident the state Division of Disaster and Emergency Services is responsible.

3. List of qualified individuals (or pages in plan which list).

Hazardous Materials Response Team Members are listed in Appendix Q-3, pages Q-3-1, Q-3-2. No qualifications are given.

4. Communications for sounding the alarm, informing the related agencies.

If more than two state agencies are involved in a hazardous materials accident situation, the Division of Disaster and Emergency Services must be notified. The Disaster and Emergency Services Official notifies the Radiation Control Branch first, then the Kentucky State Police, State Fire Marshall, Natural Resources and Environmental Protection, Department of Transportation, Division of Explosives and Blasting, Department of Agriculture, and Department of Human Resources.

5. Public information spokesperson.

All public information activities and releases will be coordinated by the Disaster and Emergency Services Coordinator at the incident scene. All state agencies will refer media inquiries to the Disaster and Emergency Services Coordinator at the incident scene or to the Public Information Officer at the Emergency Operations Center.

Appendix A-5 (continued)

6. Interstate agreements.

Interstate agreements were not mentioned.

7. Availability of training (organizations).

Training was not mentioned.

8. Available training manuals.

No manual was cited.

Appendix A-6

LOUISIANA

1. Enabling legislation and regulations.

The Louisiana Disaster Act of 1974 (Act No. 636, Chapter 6) and the Louisiana Civil Defense Law of 1950 (Act No. 38 as amended).

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The Nuclear Energy Division has the overall responsibility for the administration, implementation, application and coordination of radiological emergency procedures in the event of a radiological incident. Other agencies and their responsibilities are given on pages 2-3 and in Appendices III and IV.

3. List of qualified individuals (or pages in plan which list).

Names were given on pages 36-40. No qualifications were given.

4. Communications for sounding the alarm, informing the related agencies.

The Nuclear Energy Division begins the notification procedure. They notify other state agencies as appropriate.

5. Public information spokesperson.

Public information is to be provided by the Nuclear Energy Division. The Administrator (Team Captain) is responsible for notification of the public through various news media and to provide an evaluation of the incident in terms of public health. Also see Appendix VII.

6. Interstate agreements.

No interstate agreements were mentioned.

7. Availability of training (organizations).

The Nuclear Energy Division will conduct a training program as specified in Appendix VIII on page 26.

Appendix A-6 (continued)

8. Available training manuals.

No manual was cited.

Appendix A-7

MARYLAND

1. Enabling legislation and regulations.

Civil Defense and Disaster Preparedness Act, Article 15 of the Annotated Code of Maryland and Article 43 Section 680 of the Annotated Code of Maryland.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

County governments are responsible for any radiological emergency until their resources are exhausted, inadequate or unavailable to mitigate an emergency. At this point, they contact the state government agencies through the Department of Civil Defense and Disaster Preparedness. Specific agencies and their responsibilities are given on pages Q-4-1 through Q-4-3. See also Tables Q-5-2 and Q-5-3.

3. List of qualified individuals (or pages in plan which list).

No names or qualifications were given.

4. Communications for sounding the alarm, informing the related agencies.

See Figure Q-5-3 and Table Q-5-1.

5. Public information spokesperson.

The state and counties coordinate efforts with fixed nuclear facilities to develop a public information program as covered on pages Q-5-2 through Q-5-5.

6. Interstate agreements.

Maryland is currently formalizing mutual aid compacts with contiguous states. A mutual aid agreement exists between Maryland and the District of Columbia.

Appendix A-7 (continued)

7. Availability of training (organizations).

The Maryland Civil Defense and Disaster Preparedness Agency is responsible for the overall development of exercise and drill scenarios and for training programs. Section 6 of the Plan -- Plan Testing and Maintenance, pages Q-6-1 through Q-6-3 gives details.

8. Available training manuals.

No manual was cited.

Appendix A-8

MISSISSIPPI

1. Enabling legislation and regulations.

No information available.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

No information available.

3. List of qualified individuals (or pages in plan which list).

No information available.

4. Communications for sounding the alarm, informing the related agencies.

No information available.

5. Public information spokesperson.

No information available.

6. Interstate agreements.

No information available.

7. Availability of training (organizations).

No information available.

8. Available training manuals.

No information available.

Appendix A-9

MISSOURI

1. Enabling legislation and regulations.

Executive Order 79-19.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The Disaster Planning and Operators Office, Office of the Adjutant General, shall be the coordinating agency for response to emergencies involving radiation. Their responsibilities and the responsibilities of other state agencies as designated appropriate to the incident are given on pages 4-8.

3. List of qualified individuals (or pages in plan which list).

Listing of qualified personnel is given in Appendices A-1 through H-6.

4. Communications for sounding the alarm, informing the related agencies.

Initial notification of a radiological incident is made to Disaster Planning and Operations, Office of the Adjutant General. They in turn contact the Nuclear Emergency Team Coordinator who with local officials would continue the notification. This continuation is not explicitly stated. Page 8 covers the procedure.

5. Public information spokesperson.

Statements of immediate interest should be made through local authorities with technical guidance from the Missouri Nuclear Emergency Team leader. State level news releases will be made through the Governor's office or the Department of Public Safety.

6. Interstate agreements.

No interstate agreements were mentioned.

7. Availability of training (organizations).

Training was not mentioned.

Appendix A-9 (continued)

8. Available training manuals.

No manual was cited.

Appendix A-10

NORTH CAROLINA

1. Enabling legislation and regulations.

These are in Chapter 62-2 and Chapter 104E. An extensive listing is given in Annex A, page 1 - Authorities and References.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The Department of Crime Control and Public Safety is responsible for allocating state resources and directing personnel and functions of other departments as required. See pages 3-14 for agencies and their specific responsibilities. See also Annex C, page 1 for an Organization Chart.

3. List of qualified individuals (or pages in plan which list).

No names or qualifications were given.

4. Communications for sounding the alarm, informing the related agencies.

The Department of Crime Control and Public Safety, Division of Emergency Management has primary responsibility for notification procedures to such agencies as are required to cope with the incident. Federal government agencies as needed will be contacted. See Annex H, page 1 for communications methods.

5. Public information spokesperson.

Local government is responsible for public information until such time as the State Emergency Response Team assumes responsibility. For hazardous substances spills, the Department of Natural Resources and Community Development is responsible for spill information prior to activation of the State Emergency Response Team.

6. Interstate agreements.

As provided by agreement through the Southern Mutual Radiation Assistance Plan, other states in accordance with the situation will be contacted. See pages 14-15 for details.

Appendix A-10 (continued)

7. Availability of training (organizations).

The Division of Emergency Management has primary responsibility for training program as given on pages 18-19.

8. Available training manuals.

No manual was cited.

Appendix A-11

OKLAHOMA

1. Enabling legislation and regulations.

Governor's E.O. in 1958 and House Bill #512 of 1967.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

Under control of the Director of Occupational and Radiological Health Services, Department of Health. Also involved are Oklahoma Civil Defense and Department of Public Safety. Page 7 in the Health Annex and pages 1-4 in internal plan give responsibilities in detail.

3. List of qualified individuals (or pages in plan which list).

Listing of 1976 County Medical Society Officers is given in Appendix 10 to Health Annex-Natural Disaster Plan. No qualifications for radiological emergencies are given.

4. Communications for sounding the alarm, informing the related agencies.

When an emergency occurs, the Oklahoma Civil Defense and Occupational and Radiological Health Service must be notified as listed on page 9 of the Health Annex. Communications are directed by the Occupational and Radiological Health Service once they have been notified.

5. Public information spokesperson.

No public information spokesperson was mentioned.

6. Interstate agreements.

If the emergency involves a very large-scale spread of radioactive materials, the possibility exists that the Occupational and Radiological Health Services may recommend that the Governor request radiation control personnel from surrounding states through the Southern Mutual Radiological Assistance Plan (SMRAP). Page 3 - internal plan.

Appendix A-11 (continued)

7. Availability of training (organizations).

Training was not mentioned.

8. Available training manuals.

No manual was cited.

Appendix A-12

SOUTH CAROLINA

1. Enabling legislation and regulations.

Act No. 223 of 1967 of the General Assembly of the State of South Carolina and subsequent amendments to the Act.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The Bureau of Radiological Health of the Department of Health and Environmental Control has primary responsibility. The Emergency Preparedness Division of the Adjutant General's Office has primary operational control. State agencies and their responsibilities are given on pages 11-21.

3. List of qualified individuals (or pages in plan which list).

List of names is given on pages A5 through A6. No qualifications are given.

4. Communications for sounding the alarm, informing the related agencies.

Emergency notification is begun by the Bureau of Radiological Health and continued as given in Annex A - Alert and Notification.

5. Public information spokesperson.

The Governor's Press Secretary or authorized representative will direct and control the Public Information Service Response Groups activities and serve as the official spokesperson regarding the preparation and release of emergency information by state government. See Annex C -- Public Information.

6. Interstate agreements.

There is an information exchange agreement between South Carolina and Georgia, see page 74, Table 7.2. and a similar agreement between North Carolina and South Carolina, see page 73, Table 7.1. The Southern Mutual Radiation Assistance Plan is in force.

Appendix A-12 (continued)

7. Availability of training (organizations).

Periodic training sessions will be coordinated by the DHE and EPD as given in Annex B -- Training and Annex D -- Exercise and Drills.

8. Available training manuals.

Included within this plan is the "Technical Radiological Emergency Response Plan," which may be considered a manual.

Appendix A-13

TENNESSEE

1. Enabling legislation and regulations.

- 1) Public Law 93-288, the Disaster Relief Act of 1974.
- 2) Public Law 91-606, The Disaster Relief Act of 1970, Sections 231, 233, 234, 235, 236, 237, 301, 302, 303 and 304.
- 3) Part 2205, Title 24, FDAA, Code of Federal Regulations, May 1975.
- 4) Governor's E.O. No. 18, July 31, 1975.
- 5) Volume 3, Title 7, Chapter 5, Section 7-601 through 7-630, Tennessee Code Annotated.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The Tennessee Department of Public Health has the overall responsibility. It utilizes as necessary the assistance of federal, state, and local agencies. See pages 7a-d, 9, 36-39, 47-85 for agencies and responsibilities.

3. List of qualified individuals (or pages in plan which list).

Listings are given on pages 8a-d, 41a, 57, 60, 63, 66, 69, 71, 77, 80, 82, 84 and 85. No qualifications are mentioned.

4. Communications for sounding the alarm, informing the related agencies.

The Tennessee Office of Civil Defense and Emergency Preparedness on receiving notification from the Department of Health contacts the necessary state agencies. The notification procedure appears on page 41.

5. Public information spokesperson.

The Commissioner, Tennessee Department of Public Health, or the Governor's Office shall release necessary information to the public through various news media.

6. Interstate agreements.

Southern Mutual Radiation Assistance Plan as given on pages 18-20.

Appendix A-13 (continued)

7. Availability of training (organizations).

The Department of Public Health in cooperation with the Office of Civil Defense and Emergency Preparedness will conduct seminars, exercises or other forms of training from time to time to acquaint personnel with the provisions of their plan and expected responses to certain emergencies. Training will occur at least annually.

8. Available training manuals.

No manual was cited.

Appendix A-14

TEXAS

1. Enabling legislation and regulations.

Section 21.403, Texas Regulations for Control of Radiation. The Radiation Control Act, Article 459 of Revised Civil Statutes.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The Department of Health, Division of Occupational Health and Radiation Control has primary responsibilities given on pages 6-8. It activates the Disaster Emergency Services Council when necessary. Through the Council, other Texas state agencies are requested to provide emergency responses outlined in their respective Annex of the EOP.

3. List of qualified individuals (or pages in plan which list).

No names or qualifications are given.

4. Communications for sounding the alarm, informing the related agencies.

The Radiation Control Branch (RCB) is the primary notification agency. Other agencies are notified at the discretion of the RCB either directly or through the Disaster Emergency Services Council.

5. Public information spokesperson.

The Radiation Control Branch Director is responsible for public information.

6. Interstate agreements.

No interstate agreements were mentioned.

7. Availability of training (organizations).

The Department of Health, Division of Occupational Health and Radiation Control has the responsibility for training staff. Details of training are not given.

Appendix A-14 (continued)

8. Available training manuals.

No manual was cited.

Appendix A-15

VIRGINIA

1. Enabling legislation and regulations.

Governor's E.O. number 42(80) of June 9, 1970 and Title 44, Chapter 3.3, Section 44-146.30 of Authority I.A. 1.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

Local government officials of the political jurisdiction in which the accident occurs are responsible for the overall response as it affects the general public. Technical guidance and assistance in the radiological aspects will be provided by the State Department of Health. The overall state response will be coordinated by the State Office of Emergency and Energy Services.

3. List of qualified individuals (or pages in plan which list).

No names or qualifications are given.

4. Communications for sounding the alarm, informing the related agencies.

Local government would be notified first and would notify other agencies as necessary. See pages 14-2 through 14-3.

5. Public information spokesperson.

No public information spokesperson was mentioned.

6. Interstate agreements.

No interstate agreements were mentioned.

7. Availability of training (organizations).

The State Office of Emergency and Energy Services will provide an on-going training program for instructing and qualifying state and local personnel to perform necessary emergency functions. A detailed plan is given in Appendix 12.

Appendix A-15 (continued)

8. Available training manuals.

No manual was cited.

Appendix A-16

WEST VIRGINIA

1. Enabling legislation and regulations.

West Virginia Code, Chapter 15, Article 5, as amended.

2. Participating agencies and their responsibilities; title to each administrator, (or pages in plan that have a title listing).

The primary responsibility differs as to the task. The Department of Health has primary responsibility for Emergency Health Services. Task assignments to various state agencies are given on page A-1.

3. List of qualified individuals (or pages in plan which list).

No names or qualifications were mentioned.

4. Communications for sounding the alarm, informing the related agencies.

The Department of Emergency Services has the primary responsibility for communications as given in Annex C and Appendix 1 to Annex c.

5. Public information spokesperson.

The Governor's Press Office has primary responsibility for public information as given in Annex P.

6. Interstate agreements.

No interstate agreements were mentioned.

7. Availability of training (organizations).

Training was not mentioned.

8. Available training manuals.

No manual was cited.